

BULLETIN

OF THE INSTITUTE OF METALS

VOLUME 6

SEPTEMBER 1961

PART I

INSTITUTE NEWS

Election of Members to Fill Vacancies on the Council in 1962-63

In accordance with the Institute's Articles of Association, certain Members of Council retire at the Annual General Meeting each year. At the 1962 Annual General Meeting the following will retire: Professor H. O'NEILL (*President*); Dr. L. B. PFEIL (*Past-President*); Professor H. FORD and Mr. E. H. JONES (*Vice-Presidents*); and Dr. L. B. HUNT, Lord KIRKWOOD, and Mr. F. W. TOMLINSON (*Ordinary Members*).

Under Article 19, Professor H. O'NEILL, M.Met., D.Sc., F.I.M., will fill the vacancy on the Council as Past-President.

In accordance with Article 22, the Council nominates the following members to fill the vacancies on the Council as President and Senior Vice-President:

As President

The Right Hon. The Earl of VERULAM, Chairman and Managing Director of Enfield Rolling Mills, Ltd., Brimsdown, Middlesex.

As Senior Vice-President

Professor H. FORD, D.Sc.(Eng.), Ph.D., M.I.Mech.E., M.I.C.E., Professor of Applied Mechanics, Imperial College of Science and Technology, University of London.

The Council nominations for the remaining vacancies on the Council (2 Vice-Presidents and 3 Ordinary Members) will be announced in accordance with the Articles of Association at a General Meeting of the Institute to be held at 9.30 a.m. on Monday, 16 October 1961, in the Assembly Room, The Royal Commonwealth Society, Craven Street, London, W.C.2.

Members are reminded that, in accordance with Article 22, any ten members may also at, or before, the business part of that General Meeting, nominate in writing, with the written consent to act of the person nominated, any duly qualified person to fill any vacancy on the Council, but each such nominator is debarred from nominating any other person for the same election. If any two or more persons are nominated for any honorary office, they (or such of them as are not Ordinary Members of Council who are not retiring at the next Annual General Meeting) will be deemed to have been nominated also for any vacancies among the Ordinary Members of Council. No person is eligible to fill any vacancy at such Annual General Meeting unless he has consented in writing to be nominated and has been nominated or deemed to be nominated for the same in compliance with this Article.

Subscriptions for 1961-62

Members are reminded that their subscriptions for 1961-62 are now due. Payment is facilitated by the use of a Banker's Order, and the necessary form can be obtained from the Secretary.

"Metallurgical Reviews" No. 22

Metallurgical Reviews No. 22, which appeared recently, contains: "The Production of Non-Ferrous Metal Slab and Bar by Continuous Casting and Rolling Methods", by D. M. Lewis; "Dispersion-Strengthened Aluminium Alloys", by E. A. Bloch; and "Applications and Uses of Titanium and Its Alloys", by R. L. Preece and K. W. J. Bowen.

This quarterly publication is available only by subscription, the rates being: members 32s. 6d. (\$5.00) post free; non-members 50s. (\$7.50) post free.

Election of Members

The following 21 Ordinary Members, 4 Junior Members, and 10 Student Members were elected on 14 July 1961:

As Ordinary Members

- BARONE, IVO, Production Superintendent, Alumínio do Brazil, S.A., Caixa Postal 8039, São Paulo, Brazil.
- BRADSHAW, James Ronald, Chief Chemist, Nobrac Carbon, Ltd., Commerce Way, Lancing, Sussex.
- BYRON, Anthony George, Aeronautical Inspection Directorate, Slough, Bucks.
- CHANTRY, Francis James, A.Met., A.I.M., Manager, Heeley Rolling Mills, Ltd., Sheffield 2.
- DANIELS, Raymond De Witt, B.S., M.S., Ph.D., Assistant Professor of Metallurgical Engineering, University of Oklahoma, Norman, Okla., U.S.A.
- DENIS, Pierre Louis, M.Sc., Production Manager, E. & E. Kaye, Ltd., Ponders End, Enfield, Middlesex.
- DOUTHWAITE, Robert Michael, B.Sc., A.I.M., Lecturer in Metallurgy, Houldsworth School of Applied Science, The University, Leeds 2.
- DOWSON, John, B.Sc., Metallurgist, Vauxhall Motors, Ltd., Luton, Beds.
- GEBALSKI, Stanislaw, Dr.Tech.Sci., Chief Metallurgist, Instytut Mechaniki Precyzyjnej, and Associate Professor, Warsaw Technical High School, Warsaw, Poland.
- GRINDROD, Bernard, Senior Lecturer, Mechanical Engineering, Royal College of Nairobi, Kenya.
- HOOPER, John Joseph, Joint Managing Director, Industrial Newspapers, Ltd., John Adam Street, London, W.C.2.
- JOHNSON, William, B.Sc., Professor of Mechanical Engineering, College of Science and Technology, Manchester 1.

PERSONAL NOTES

- KNOWLES, Keith, British Iron and Steel Research Association, Hoyle Street, Sheffield 3.
- LYNCH, John P., Jr., S.B., Metallurgist, Ansonia Division, Anaconda American Brass Co., Ansonia, Conn., U.S.A.
- MANSON, Peter John, B.Sc., Manager, D. L. Lombard and Sons, Engineering, Ltd., 19 Grosvenor Place, London, S.W.1.
- MOORADIAN, Ara J., B.Sc., M.Sc., Ph.D., Atomic Energy of Canada, Ltd., Chalk River, Ont., Canada.
- NILESHWAR, Vivek Baburao, B.Sc., Ph.D., Isaac Wolfson Research Fellow, Department of Metallurgy, University of Oxford.
- OKAMOTO, Masazo, Dr.Eng., Professor of Metallurgy, Tokyo Institute of Technology (Tokyo Kogyo Daigaku), Ookayama, Meguro-ku, Tokyo, Japan.
- OLNEY, Eric Bertie, Research Metallurgist, Murex, Ltd., Rainham, Essex.
- VERBRAAK, Cornelis Antonius, Head of Department of Fundamental Research, Metaalinstutut T.N.O., Postbus 52, Delft, Netherlands.
- WEISZ, Michel, Ing.E.C.P., Ing.Dr., Service de Technologie, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette (S. et O.), France.

As Junior Members

- MILLER, Geoffrey Paul, B.Sc., Graduate Student, Battersea College of Technology, London, S.W.11.
- ROGERSON, John Herbert, B.A., Research Officer, British Welding Research Association, Abington Hall, Cambridge.
- WAI, Tsang Yuen, Sun Kung Metal Extrusion Works, Ltd., 8 Factory Site, Fuk Wah Village, Ngau Tau Kok, Kowloon.
- WILLIAMS, William Michael, B.Sc., Physicist, Hirst Research Centre, General Electric Co., Ltd., Wembley, Middlesex.

As Student Members

- ATTWOOD, Brian, Metallurgical Student, Manchester University.
- AUCOUTURIER, Marc Hubert-Louis, Ing.Civil des Mines, Centre de Recherches Métallurgiques, l'Ecole National Supérieur des Mines, 60 Boulevard St. Michel, Paris 6^e.
- AYER, Robert, B.Sc., Research Student, Department of Metallurgy, King's College, Newcastle-upon-Tyne.
- CANNING, Geoffrey Thomas, Metallurgical Student, University of Manchester.
- EACOTT, John Graham, Metallurgical Student, University of Manchester.
- GWYNNE, Peter, Metallurgical Student, University of Oxford.
- KAH, David Harvey, B.S., Graduate Student, Department of Chemical and Metallurgical Engineering, University of Cincinnati, Cincinnati 21, O., U.S.A.
- LEE, William Leroy, Materials Engineer, General Motors Corp., AC Spark Plug Division, Milwaukee, Wis., U.S.A.
- O'NEILL, Dennis, B.S., Graduate Student, Metallurgical Department, Missouri School of Mines and Metallurgy, Rolla, Mo., U.S.A.
- WOODARD, Claude L., B.S., M.S., Postgraduate Student, Missouri School of Mines and Metallurgy, Rolla, Mo., U.S.A.

PERSONAL NOTES

MAJOR C. J. P. BALL has retired from the Board of The Distillers Co., Ltd.

DR. D. J. BLICKWEDE has been appointed Director of Research, Applications, to the Bethlehem Steel Corp., Bethlehem, Pa.

MR. D. F. CAMPBELL is retiring this month from the Chairmanship of Davy-Ashmore, Ltd.

MR. M. E. CRONIN is now a development engineer with the General Electric Co., Ltd., Semiconductor Division, Hazel Grove, near Stockport.

MR. C. H. DAVY, a Director of Babcock and Wilcox, Ltd., has been elected a Vice-President of the Institute of Welding.

DR. R. GENDERS, Consultant, has been elected to the Board of Arnott and Harrison, Ltd.

DR. BRUCE W. GONSER, Technical Director, Battelle Memorial Institute, has been appointed a director of the American Society for Testing Materials.

DR. F. R. HENSEL has left P. R. Mallory and Co., Inc., to join Clyde Williams and Co., Columbus, O., and its associated companies.

MR. J. O. HITCHCOCK has been appointed to the Board of Anglo Metal Co., Ltd.

DR. D. HULL has been appointed Senior Lecturer in Metallurgy in the University of Liverpool.

PROFESSOR J. T. NORTON, of the Massachusetts Institute of Technology, was awarded the Plansee Plaque at the Fourth International Plansee Seminar held in June at Reutte, Austria. He is the first American to receive the plaque, which is given in recognition of fundamental contributions in the field of powder metallurgy.

DR. D. V. RAGONE, Associate Professor of Chemical Engineering in the University of Michigan, is now Senior Research Engineer with the Conduction Corp., Ann Arbor (Mich.) Division. He retains his affiliation with the University on a part-time basis.

DR. R. J. RAUDEBAUGH, International Nickel Co., Inc., has been nominated Vice-President of the American Society for Metals.

MR. G. SHAW SCOTT, Secretary Emeritus, has been elected a Vice-President of the Automobile Association in recognition of 20 years' service on the Executive Committee.

DR. I. S. SERVI has been appointed Vice-President of Special Metals Inc., which recently took over the Metals Division of Kelsey-Hayes, of which Dr. Servi was Technical Director.

MR. S. WOOLDRIDGE, a director of Metal Sales, Ltd., has been elected President of the Birmingham Junior Chamber of Commerce.

Deaths

The Editor regrets to announce the death of:

MR. SIDNEY SHILVOCK CHATWIN, production manager of Johnson, Matthey and Co., Ltd., Birmingham, on 20 May 1961.

PROFESSOR SIR KARIAMANIKKAM SRINIVASA KRISHNAN, F.R.S., Director of the National Physical Laboratory, New Delhi, on 14 June 1961.

OBITUARY

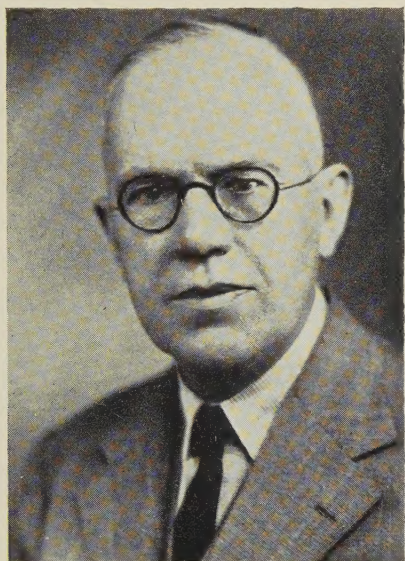
Dr. A. G. C. Gwyer

We regret to record the sudden death on 27 June 1961, of Dr. A. G. C. Gwyer in his 81st year.

Alfred George Cooper Gwyer was born in Bristol on 30 October 1880, of a family which had an association with that city dating back at least to 1768, when the name of his great-great-grandfather, James Gwyer, first appears on the Burgess Rolls.

A graduate of London University, Dr. Gwyer took his Doctorate at Göttingen, in Germany, and also received part of his education at the Universities of Bristol and Birmingham. He was a Capper Pass Metallurgical Scholar and a Royal Exhibitioner of 1851.

Starting work at the National Physical Laboratory, Teddington, in 1911, he joined The British Aluminium Co., Ltd., as Research Metallurgist in 1912, becoming Chief Metallurgist in 1920, and Scientific Manager in 1939. He retired in 1945. During his time with that Company, there took place under



his direction many notable developments in the evolution of aluminium and its alloys, and he was author and joint author of numerous scientific papers in this field.

Dr. Gwyer was a firm believer in the value of Institutional work and was an Original Member of the Institute of Metals. He served twice as a Member of Council (1928-31 and 1943-47) and once as Vice-President (1931-37). He was also President of the Manchester Metallurgical Society for 1923-24, and a Founder Member of the Institution of Metallurgists. In addition, he was prominently associated at various times with the work of the Welding Research Council, the Institute of Welding, the British Standards Institution, and the British Non-Ferrous Metals Research Association.

Although his ancestors had been in Bristol for so long, Dr. Gwyer himself lived for virtually the whole of his working life and retirement at Lymm, in Cheshire, becoming a well-known figure in the town of Warrington, owing, at least in part, to his lengthy and prominent connection with the Warrington Club. His principal hobby was motoring, and

he was always very proud of the fact that he held a licence dating back to 1905.

LOCAL SECTION LECTURE

"Ferrous or Non-Ferrous"

For his Chairman's Address to the Sheffield Local Section on 6 March, Dr. K. W. ANDREWS chose the title "Ferrous or Non-Ferrous".

He drew attention to statistics showing the relative tonnages of ferrous and non-ferrous metals, their economic value, and the proportion of net output spent on research. These figures were relevant to the usage of the materials and the somewhat different emphasis on research and development. Thus modern ferrous metallurgy stood on the twin foundations of the physical chemistry of the processes and the physical metallurgy of the product from the ingot stage, although it had to be admitted that non-ferrous metallurgy also required both. The only real difference was in the relative amounts of effort necessary or desirable in respect of the two divisions.

The distinction between ferrous and non-ferrous seemed less important when the large common ground, in physical metallurgy in particular, was considered. There was, for example, the common atomic basis, the problems of the metallic bond, and the transition metals. The same alloy systems could be considered to be ferrous or non-ferrous according to the viewpoint of the user. Simple structures, precipitation-hardening, and martensite transformations were also part of the common ground.

These observations were supported by a schematic representation of the sort of metal, whether ferrous or non-ferrous, which was actually produced or used. Real metallic materials could be regarded as resulting from a "progressive degeneration" or departure from a perfect crystal involving, for example, the introduction of vacancies, dislocations, domains, grain boundaries, precipitates, internal strains, and so on. Not all of the possible effects had to be present at the same time or relevant if present. Many would be present in all commercial products. This approach pointed to many phenomena which were the subjects of fundamental research but also embraced the various causes of weakness or defectiveness in commercial products—some of which came within the reach of methods of non-destructive examination and inspection.

Another group of (physical) metallurgical phenomena, associated with equilibrium, or the approach to it, and alloying, was also represented by a scheme which was originally devised for iron alloys but was generally applicable. Iron, having two different crystal structures, could undergo the martensitic transformation, but it could be alloyed to produce precipitation-hardening and other effects originally more closely associated with certain non-ferrous metals. Some of the latter were not structurally as versatile as iron but had compensating advantages. The aims of research included the use of this kind of physical or structural metallurgy in the control of production or properties and as a basis of development.

When a metal was considered in this way, first as a structure and secondly in regard to the modifications that could be made by producing structural changes (e.g. by alloying or heat-treatment), it again became apparent that the accepted

DISTORTION IN TOOL STEELS

A NEW BOOK PUBLISHED BY AMERICAN SOCIETY FOR METALS

Distortion in Tool Steels is a practical, easy-to-read book exploring the size and shape changes in tool steels which occur during and after processing.

Readers will benefit greatly from the experience of its author. Dr. Lement's background includes both theoretical and practical work in this field and in this book he has sorted the most useful data yet assembled on this expensive problem to industry. His comprehensive knowledge has resulted in this first-of-its-kind book for metals and materials engineers, tool engineers, designers, heat treaters, machinists, mechanical engineers and inspectors.

Dr. Lement places particular emphasis on methods of heat treatment that are necessary for precise dimensional control. The problems encountered in the production of tool steel parts with extreme tolerances (cutting tools, dies, gages, ball bearings, valves, etc.) are treated in detail.

Also, how to prevent significant changes in finish dimensions during storage or under normal service conditions is discussed. How to minimize or eliminate costly finish machining operations by scientific dimensional control is thoroughly explored.

Tables, drawings, charts and graphs highlight the book's eight chapters:

- | | |
|---------------------------------------|------------------|
| 1. CAUSES OF DISTORTION | 5. HARDENING |
| 2. MEASUREMENT OF DIMENSIONAL CHANGES | 6. COLD TREATING |
| 3. CALCULATION OF SIZE CHANGES | 7. TEMPERING |
| 4. CONTROL OF DISTORTION | 8. AGING |

If you are directly or indirectly related to the manufacture of tool steels or tool steel parts, *Distortion in Tool Steels* is a work of great importance. Dr. Lement writes to the men responsible for tool steel performance. His book represents an opportunity to become fully informed on size and shape changes in tool steels. Order your copy today.

ORDER WITH THIS COUPON

Distortion in Tool Steels—173 P.—8 chapters—illustrated—red cloth cover—6" × 9"—published by American Society for Metals—written by Dr. Bernard S. Lement—\$10.00 per copy. Please add \$1.00 for postage.

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dichotomy was mostly irrelevant. The metallurgical product obviously involved one in a wide variety of experience and phenomena within this unity. The speaker believed that this was one reason why many metallurgists had a real interest in and enthusiasm for their subject.

OTHER NEWS

Joint International Conference on Creep and Fracture, 1963

A Joint International Conference on Creep and Fracture will be held in New York from 25 to 28 August 1963 and in London during October 1963. The sponsors are the American Society of Mechanical Engineers, the Institution of Mechanical Engineers, and the American Society for Testing Materials.

The Conference will be devoted to the mechanical properties of engineering materials at elevated temperatures, the emphasis being on the utilization, by the mechanical engineer, of creep and rupture data on current materials in the design of equipment to be used at elevated temperatures.

The scope of the Conference will be as follows:

Fundamentals of Creep and Fracture

Mechanisms—atomic lattice; dislocation; material; metallurgical structure, &c.

Plasticity theory in creep—theoretical and experimental studies in uniaxial or combined stresses.

Studies in relaxation, thermal and mechanical cycling, rapid and dynamic creep.

Design for Creep and Fracture

Criteria for design—uniaxial and combined stress, thermal and mechanical cycling, relaxation, and creep behaviour of composite materials.

Application and interpretation of creep and fracture data—information concerning particular materials, short- and long-time tests and extrapolation of data.

Service Experience of Creep and Fracture

Correlation—service data with laboratory tests and methods of testing.

Environmental effects—oxidation, corrosion, ablation, erosion, radiation, &c.

Tentative offers of papers, emanating from the United Kingdom, Africa, Asia, Australasia, and Europe, with the exception of Japan and the U.S.S.R., outlining briefly the scope, should be sent *as soon as possible* to: The Secretary, The Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1. Copies of letters should be sent for information to: Mr. N. L. Mochel, Conference Secretary, Westinghouse Electric Corporation, Steam Division, Lester Branch P.O., Philadelphia 13, Pa., U.S.A.

Offers of papers must be confirmed by abstracts not exceeding 250 words before 1 June 1962. Manuscripts must be received by 1 December 1962 for refereeing by the appropriate Organizing Committee. A Guide to the Preparation of Papers, giving the requirements laid down by the Committee, will be sent to all authors whose abstracts are accepted. The Proceedings of the Conference will be published in the English language, but manuscripts may be submitted in any language.

Preprints of papers will be issued to delegates in advance of the Conference, and the Reporter system will be used in presenting papers for discussion. Simultaneous interpretation facilities in English, French, and German will be provided at the London meetings.

All enquiries should be addressed to: The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1.

Symposium on Corrosion in the Nuclear-Energy Industry

The sixteenth meeting of the European Federation of Corrosion will take the form of a Symposium on Corrosion in the Nuclear-Energy Industry, with particular reference to corrosion of sheath materials. It will be held at the Maison de la Chimie, Paris, on 19 and 20 October 1961.

The meeting is being organized by the Société de Chimie Industrielle, 28, rue Saint-Dominique, Paris (7^e), from which details may be obtained. Registration forms for the meeting must be returned by 2 October.

The programme, arranged by a committee under the chairmanship of Professor G. Chaudron, is as follows:

Thursday, 19 October

"Researches on the Corrosion of Zirconium Alloys in Superheated Steam", by Dr. U. Rosler.

"Corrosion of Zirconium and its Alloys in Steam", by J. N. Wanklyn.

"Study of the Effect of Various Factors (Thermal Flux, Vibrations, Pressure, Addition of Lithia) on the Corrosion of Zircaloy by Water or Steam at High Temperature and the Absorption of Hydrogen by the Metal", by H. Coriou, L. Grall, J. Hure, M. Pelras, and H. Willermoz.

"Corrosion Behaviour of Niobium Alloys and Inconel, Used Respectively as Sheathing Materials and Structural Materials in Pressurized Water Reactors", by Warren E. Berry.

Friday, 20 October

"Oxidation at High Temperatures and Conditions of Inflammability of Magnesium-Base Sheathing Alloys in Great Britain", by C. Tysack and P. B. Longton.

"Corrosion of Beryllium in Carbon Dioxide under Pressure at High Temperature", by R. Darras, D. Leclercq, and B. Dewanckel.

"Galvanic Corrosion Effects during Storage under Water, after Discharge, of Combustible Elements Sheathed with Aluminium", by H. G. Masterson and J. T. Harrison.

"Study of Corrosion Factors of Beryllium in Carbon Dioxide", by A. Draycott, F. D. Nicholson, G. H. Price, and W. I. Stuart.

International Conference on the Physics of Semiconductors

The Institute of Physics and Physical Society, on behalf of the International Union of Pure and Applied Physics and the British National Committee for Physics, is arranging an International Conference on "The Physics of Semiconductors", which will be held at the University of Exeter from 16 to 20 July 1962. The Conference is planned to follow the previous sequence of Conferences on the physics of semiconductors, which were held in Reading (1950), Amsterdam (1954), Garmisch (1956), Rochester, N.Y. (1958), and Prague (1960).

Accommodation will be provided in Halls of Residence at the University. Further information regarding the Conference may be obtained from the Administration Assistant, The Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1.

Course on "Techniques of Non-Destructive Testing"

An evening course of eleven lectures on "Techniques of Non-Destructive Testing" will be held in the Physics Department of Brunel College of Technology, Woodlands Avenue, Acton, London, W.3, every Wednesday from 7.00 to 8.30 p.m., beginning on Wednesday, 4 October 1961. The lectures, to be given by well-known specialists from industry and members of the college staff, will be on topics such as radiology, ultrasonics, eddy currents, magnetic methods, and thermal conductivity.

These should be of interest to inspectors and others engaged in this work and also to graduates and holders of the H.N.C. in engineering and science subjects who require an introduction to the methods employed in non-destructive testing.

Further details of the course, for which the fee will be £1, may be obtained from the Physics Department at the College.

Course on "Surface Treatment and Protection"

A course of nine lectures dealing with various aspects of the surface treatment and protection of metals is being organized by the Metallurgy Section of Enfield Technical College.

This series of lectures will deal with the general methods of protecting metal surfaces, particular attention being given to modern developments. The following aspects of the subject will be covered: surface finish and properties, sub-surface structure and properties; electroplating, principles and modern developments; surface protection by sprayed, dipped, and painted coatings; corrosion testing and evaluation of data.

The lectures will be held on successive Monday evenings beginning at 7.00 p.m. on 15 January 1962. The fee for the course is £1. Application forms and further details can be obtained from Mr. V. James, Metallurgy Section, Enfield Technical College, Queensway, Enfield, Middlesex.

"Welding Engineering 1962"

The Institute of Welding is organizing its first large-scale exhibition at Buxton next year, in connection with its Spring Meeting there. Facilities in the Winter Gardens make it possible to expand the displays and demonstrations which have been features of recent Institute meetings into a specialized exhibition of welding and the allied processes and techniques—brazing, soldering, cutting, hard facing, metal spraying, manipulating, inspection, testing, safety.

The theme of the Spring Meeting is "Welding for Power Generation". Nearly thirty papers, including several from other countries, have been specially written for this meeting, the dates of which are 30 April–4 May 1962. "Welding

Engineering 1962", as the exhibition has been named, will illustrate the rapid progress of welding technology in Britain, especially in meeting the challenge of modern power generation plant construction.

LECTURES

BATTERSEA COLLEGE OF TECHNOLOGY London, S.W.11 (Liberal Studies Section). Post-graduate evening courses for engineers and scientists, commencing October, session 1961–62. (i) Introduction to Management, 10 lecture/discussions on Wednesdays, commencing 4 October. (ii) Russian on Mondays and Fridays throughout the session, commencing 2 October. Details and enrolment forms obtainable from the Secretary (Liberal Studies).

APPOINTMENT VACANT

METALLURGISTS

and

PHYSICISTS

required by the

**CENTRAL ELECTRICITY GENERATING BOARD
RESEARCH LABORATORIES**

(Materials Division, Leatherhead, Surrey)

Advancing conditions in steam generation necessitate fundamental and applied investigations into the behaviour of ferritic and austenitic steels at high temperatures under complex stress systems. Successful candidates will join teams working on problems associated with creep, fatigue, phase changes, erosion, and oxidation. Postgraduate industrial or university experience in one of these fields is desirable but not essential. Excellent facilities for research are available and publication of results is encouraged.

These posts have arisen solely through a decision to increase our activity in these fields.

Applicants (preferably under 26 years of age) should possess a good honours degree or equivalent qualification. There are also a few vacancies for staff who are slightly less qualified academically, but who have particularly relevant experience.

● Salaries up to £1,325 per annum (or higher in exceptional cases) will be fully commensurate with responsibilities, experience, ability and qualifications, and excellent prospects exist for promotion to higher grades.

Applications stating age, qualifications, experience, present position and salary, to the Appointments Officer, 24/30 Holborn, London, E.C.1. Quote "Ref. JIM/315".